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ORTHODONTIC APPLIANCES, SYSTEMS, METHODS AND TOOLS

This application claims the benefit of U.S. provisional applications numbered 60/350232, 60/350233 and 60/396338, and U.S. non-provisional applications 10/187494 and 10/131454, each of which is incorporated herein by reference in its entirety.

Field of The Invention

The field of the invention is orthodontic appliances, systems, methods, and tools.

Background of The Invention

Dentists, orthodontists in particular, often use orthodontic hardware such as brackets and archwires in the prevention or correction of irregularities of the teeth, particularly irregularities that result in malocclusions (faulty contact between the upper and lower teeth when the jaw is closed). Dentists also use orthodontic hardware to treat teeth having undesirable orientations. Undesirable orientations generally either occur naturally or are a result of tooth repositioning during orthodontic treatment.

An orthodontic bracket is generally a metal or ceramic part fastened to a tooth to serve as a means for fastening an archwire. An archwire is a metal wire that is attached to the brackets to move the teeth of a patient in a manner desired by the patient's dentist. An example of a bracket and archwire assembly is shown in figure 1 with bracket 10 being bonded to tooth 40, and archwire 20 being coupled to bracket 10 by ligature wire 30. Bracket 10 comprises base 11, and stems 12 and 13. Stems 12 and 13 each comprise two tie wings (12A, 12B, 13A, and 13B) and an archwire receiving slot (12C and 13C).

In figure 1, bracket 10 can be characterized as having perpendicular axis A1 and A2, and tooth 40 can be characterized as having a central axis A3, and an occlusal plane P1 as shown. In treating a patient, a dentist will generally use a standard set of 24-28 brackets and 1 archwire engaged into these brackets to apply the forces needed for tooth movement.

Due to the small size of the brackets, it is generally desirable to use a holder such as a tweezers or pliers to pick up position bracket 10 on a tooth 40. The positioning and alignment of bracket 10 relative to tooth 40 is particularly important to a dentist, as it tends to strongly impact the movement of tooth 40 during treatment. As such, it is generally desirable

to position bracket 10 at a particular height relative to the top/occlusal surface of the tooth. Referring to figures 2A-2C, the position of bracket 10 may be adjusted such that: (a) the vertical distance D1, the distance between the occlusal plane P1 or occlusal surface of tooth 40 and horizontal axis A2, is a desired value; (b) the horizontal distance D2, the horizontal component of the distance between axis A1 of bracket 10 and axis A3 of tooth 40, is a desired value (possibly zero); and the angle E1 between axis A1 and axis A3 is a desired value (also possibly zero). Unfortunately, properly positioning and aligning bracket 10 is not always easy to accomplish. Because of this, tools for aiding in the holding, positioning, and aligning of brackets have been developed. Examples of such tools can be found at least in U.S. Patent Nos. 5,868,787 and 4,850,864, in U.S. Patent No. 5,810,582 and in U.S. Patent Nos. 6,296,482, 5,312,248, and 5,304,061. However, this list is not exhaustive as other types of holders, gauges, and other tools are also known.

One type of holder that is particularly suitable for comparison purposes is the bracket holding tweezer of figure 3. In figure 3, tweezer 50 comprises a pair of elongated members 51 and 51' placed in an adjacent lengthwise relationship with one another, each member having a first end part 52 and 52' and a second end part 53 and 53', the first end part forming a gripping mechanism 54, and the second end parts coupled together to form a handle 55. The tweezers of figure 3 is a pre-tensioned or cross-over type having a gripping mechanism 54 comprising a jaw which is held in the closed position by tension formed by the shape of the tweezers, in particular by the cross-over portion 56 and the coupling together of ends 53 and 53'. The user must apply pressure to the members 51 and 51' to open the jaw, align the object upon which the tweezers are to be used with, and then reduce the pressure on the members so that the object is held by the gripping area. In many instances, cross-over type holders are preferred in the placement of brackets on teeth.

The gripping jaw 54 that includes the first end parts 52 and 52' of the members 51 and 51', includes gripping surfaces 57 and 57' having front edges 58 and 58' that are typically used to grip the tie wings of an orthodontic bracket. The front edges 58 and 58' of the gripping jaws are typically inclined relative to a vertical axis to allow the holder to be angled away from the surface of a tooth during placement of a bracket. In some instances their front edges are cutting surfaces.

Archwires generally vary in regard to shape, size, and type of wire used. In previously known methods, initial selection of an archwire is typically accomplished by examination of a patient's teeth to determine what size and shape of archwire would be appropriate for that patient. In many instances, the shape to be used is determined by looking at the shape formed by the occlusal surfaces of the teeth, or by looking at the shape formed by the labial and buccal surfaces of the teeth. Unfortunately, determining an appropriate shape by looking at the occlusal or the labial and buccal surfaces of a patient's teeth does not always result in selection of the optimum archwire shape. Such selection is generally made more difficult due to variations in tooth shape, position and orientation. Moreover, although taught in school, selecting custom archwire shapes for each individual patient is generally too time consuming for the dentist/orthodontist, reducing the number of patients that can be seen in a day, and increasing the fee for those patients being treated.

Undesirable tooth orientations generally either occur naturally or are a result of tooth repositioning during orthodontic treatment. Undesirable orientations are typically corrected by using one or more of the following methodologies: (a) "bending" arch wires during formation; (b) positioning brackets in a position offset from the center of a tooth face; and (c) adjusting adhesive thickness to position a bracket close or farther from the face of a tooth. Unfortunately, these methodologies require a higher than desired degree of skill to obtain desired effects, and not all orthodontists have the requisite skill. Moreover, wire bending is time consuming and thus adds to the total amount of time an orthodontist must spend treating a particular patient. Use of wire bending methodologies also often leads to poor retention in that teeth that have been orientated correctly tend to move back to an undesired orientation after treatment is complete. As such, there is an ongoing need for improved orthodontic methods that reduce the level of skill required for successful treatment, reduce the amount of orthodontist time required for successful treatment, and have improved retention.

Summary of the Invention

It is contemplated that the prevention or correction of irregularities of the teeth of an individual patient (hereinafter "patient treatment") would be greatly facilitated through the use of the appliances, systems, methods, and tools described herein, and that the invention described herein may comprise any combination of one or more of the described appliances, systems, methods, and tools.

In regard to appliances, it is preferred that patient treatment utilize a set of brackets and an archwire customized to a particular patient. Although manufacturing brackets and wires specifically tailored to an individual would generally be desirable, the cost and time required to do so is contemplated as being economically impractical. An alternative approach described herein is to establish a larger set of "standard" brackets and wires so that brackets and wires most suitable for patient treatment can be selected from the larger set.

Unfortunately, increasing the number of brackets and wires to choose from increases the complexity of prescribing and implementing a treatment plan. However, it is contemplated that automating the diagnosis and prescription process as well as the process used for ordering orthodontic hardware will make the choice of brackets and wires much more manageable. It is also contemplated that coupling the automated prescription process to an automated ordering process will decrease the amount of orthodontic hardware that needs to be stocked by permitting the ordering of individualized sets of brackets and/or wires on an "as needed" basis.

Such an automated system would make it possible to use an individual patient's characteristics (such as the malocclusion and facial/muscle patterns), a dentists diagnosis, and the dentists treatment plan to make a personalized bracket and archwire (appliance) system for the individual patient. The advantage of doing this is to obtain superior treatment results and reducing treatment time. It is contemplated that the system disclosed herein will facilitate "straight wire finishing" so as to decrease or eliminate wire bending. The increase in variety in brackets results in less wire bending to compensate for the things the brackets cannot do. Decreasing the amount of required wire bending reduces treatment time.

To help understand the current invention, various terms and phrases will be used as names to identify and refer to different aspects of the invention. As an example, "IP Bracket Set" will be used to refer to a set of brackets, at least one of which is a preferred bracket described herein, prescribed for a particular patient, and may also include any bands, buccal tubes, or other non-archwire appliance components to be used with in conjunction with the prescribed brackets. "IP Archwire Set" will be used to refer to the one or more archwires, at least one of which is a preferred archwire described herein, prescribed for a particular patient. "IP Appliance Set" (sometimes "IP Appliance" and sometimes simply "Appliance") will be

used to refer to a combination of an IP Bracket Set and an IP Archwire Set. "IP Software" will be used to refer one or more of the software tools described herein that facilitate the prescription, ordering and use of IP Appliance Sets. "IP Diagnosis Software" will be used to refer to one or more software tools as described herein adapted to facilitate the prescription of IP Appliance Sets. "IP Ordering Software" will be used to refer to one or more software tools as described herein adapted to facilitate ordering of IP Bracket Sets and/or IP Appliance Sets. "IP Band Fitting Kit" will be used to refer to a set of bands kept in stock for the purpose of allowing a dentist to determine what size and/or type of bands need to be included in a patient's IP Bracket Set. "IP Bracket Repair Kit" will be used to refer to a set of brackets kept in stock for the purpose of quickly repairing or replacing lost or damaged brackets of an IP Bracket Set. "GMPOI Holder" will be used to refer to a bracket holder as described herein comprising a gripping member position and orientation indicator. "IP System" will be used to refer to any combination of one or more of the appliances, systems, methods, and tools described herein. Using these, an embodiment of the invention disclosed herein may be characterized as the use of the IP System for orthodontic treatment of patients, in particular the use of IP Diagnosis Software to specify an IP Appliance Set for a particular patient, using IP Ordering software to order the specified IP Appliance Set, and using a GMPOI Holder and the specified IP Appliance Set in treatment of the patient. The process of specifying an IP Appliance Set may involve the use of an IP Band Fitting Kit.

IP Software

The use of computer software for bracket selection and ordering makes the use of large numbers of brackets and archwires with specific applications possible in patient treatment at least in part because it eliminates the need for the large and expensive stockpiles of brackets and archwires that would otherwise be required, and assists in selection of an appropriate set of brackets and archwires.

GMPOI Holder

The present invention is in part directed to apparatus for holding, positioning, and aligning other apparatus such as orthodontic brackets. Preferred embodiments of such apparatus include one or more of the following: (a) a bracket gripping mechanism; (b) a horizontal position indicator; (c) a vertical position indicator; and (d) an orientation indicator.

In preferred embodiments, various portions of the apparatus serve multiple purposes, and interact with other portions to facilitate use of the apparatus. A most preferred apparatus comprises a handle, a bracket gripping mechanism, a combined orientation and horizontal position indicator, and a height gauge (vertical position indicator) that can also cooperate with the handle as an orientation indicator.

It is advantageous for a given apparatus to comprise an indicator that extends vertically upward and/or downward from the apparatus with the indicator providing a visual representation of the location of a centerline of a bracket or other apparatus being positioned. It is also advantageous to have such an indicator be non-perpendicular to a handle portion of the apparatus. If an apparatus comprises jaws, it is advantageous to position a vertically extending indicator between the jaws such that the indicator is positioned at or near the center of the gap between the jaws when the jaws are being used to hold a bracket or other apparatus. If an apparatus comprises a holder having angled jaws, it is advantageous to have such a vertically extending indicator be parallel to the jaws so as to provide a visual indication of the orientation of the jaws. Any vertically extending indicator is preferred to be near an end of a given apparatus to allow it to be close to a bracket or other apparatus being positioned and orientated. However, in the case of an orthodontic bracket holder, it is preferred that such vertically extending indicator be set at least slightly back from an end of the holder so as to avoid contact with the teeth and gums of a patient during use.

It is advantageous to be able to use most of the length of an elongated apparatus to provide a visual indication of the orientation of a bracket or other apparatus being positioned as the longer the indicator means is, the easier it is to determine improper orientation of the apparatus being positioned.

It is advantageous to include both position and orientation indicators on a holder apparatus so as to allow a bracket or other apparatus to be positioned and aligned without having to utilize a separate tool. It is contemplated that one advantage of using such an apparatus is that, particularly when dealing with using a fast setting bonding material to bond a bracket to a tooth, proper position and orientation can be obtained earlier during the setting process with a resultant reduction in risk of damage to the bond that that can be caused by movement during later stages of the setting process.

A desirable apparatus can be obtained by modifying an existing bracket holder by adding a height gauge to the handle of a standard bracket holder, and mounting a vertical bar near the jaws of the holder. In such a configuration, the vertical bar can be used simultaneously as both a position and orientation indicator. The height gauge can be used first as a height gauge, and subsequently as an orientation indicator in cooperation with a handle of the holder.

It is preferred that an included height gauge have a bracket contact portion set at a fixed distance from a tooth contacting portion will be advantageous. It is also preferred that the bracket contact portion be adapted to fit within the archwire receiving slots of the stems of a bracket, and, preferably, to comprise a wire loop or other mechanism that permits the bracket holder to be positioned horizontally while being received by the archwire receiving slots even if such slots are tilted upward or downward.

When a height gauge is part of a bracket holder, rotating the height gauge ninety degrees relative to the jaws of the holder will, in many instances, position the holder relative to the gauge so as to best cooperate with the gauge to act as an orientation indicator.

If a bracket holder apparatus comprises multiple planar members adapted to be partially inserted into a bracket or other apparatus, it is preferred that the members be co-planar and positioned relative to the remainder of the apparatus so as to best use the remainder of the apparatus of the orientation of the planar members.

It is contemplated that it is advantageous to provide orthodontic bracket holders in sets with each holder in the set being dedicated to positioning a bracket on a particular tooth, and each holder having a height gauge set to a fixed height that corresponds to the height at which a bracket is to be positioned on the tooth corresponding to the holder.

IP Archwire Sets

The present invention is in part directed to selection of individual patient archwires by examining the patients inner arch rather than the patients teeth. In particular, a preferred method of archwire selection comprises (a) obtaining a representation of a patient's inner arch curve (a "PIAC"); (b) selecting an archwire shape based at least partially on the PIAC representation; (c) making an initial selection of an archwire size based at least partially on

the PIAC representation; (d) selecting a final archwire size after considering something other than the PIAC representation; and (e) selecting an archwire to be used based on the selected archwire shape and selected final archwire size. Using the PIAC rather than the occlusal or labial and buccal surfaces of the teeth for archwire shape selection promotes shaping the teeth to the shape of the jaw bone, and gives consistent facial esthetics plus better retention of the treatment correction.

It is contemplated that such a method of archwire selection may advantageously be at least partially used as part of an automated system for selecting an archwire for a patient comprising: a patient internal arch curve recorder adapted to obtain a representation of the patient's internal arch curve; data on available archwires; and a mechanism adapted to compare an obtained representation of a patient's internal arch curve with the data on available archwires and to identify an archwire based on any such comparison. Similarly, it may advantageously be used, at least in part, in a system for selecting and ordering an archwire for a patient comprising means for selecting an archwire from a plurality of available archwires; and means for ordering the selected archwire from an archwire supplier; wherein the selection of an archwire is based, at least in part, on all of the following factors: the patient's jawbone structure; a dentists preferred treatment option; and the sizes and shapes of available archwires.

IP Bracket Sets

The present invention is in part directed to improved orthodontic methods and apparatus that reduce the level of skill required for successful treatment, reduce the amount of orthodontist time required for successful treatment, and have improved retention. More particularly, methods are described that involve identifying and/or anticipating undesired orientations prior to or early in treatment and selecting brackets for use during treatment that are adapted to correct such undesired orientations. Brackets for use in such methods are also described.

One aspect of the invention is a method of treatment involving early correction or over correction of tooth orientation. Other aspects related to early correction are: (a) early identification of mis-oriented (those having undesired orientations) teeth in regard to the types of rotations that would be required to rotate each of such teeth form its proper

orientation to its actual orientation; and (b) the use of shaped archwires to identify mis-oriented teeth. The use of shaped archwires to check tooth orientation can also be used after initial treatment to determine whether the desired amount of correction or over correction has been obtained. It is contemplated that early identification and treatment of mis-orientations will result in better retention after treatment completion.

Additional aspects of the invention are: (a) the use of brackets adapted to correct for specific types of mis-orientations and (b) the use of visual indicators on brackets to facilitate proper bracket selection. It is contemplated that the use of brackets adapted to provide particular types of correction will minimize or eliminate the need for wire bending during treatment.

Yet another aspect of the invention is the use of automated methods to identify or predict mis-orientated teeth (teeth having undesired orientations and characterizable as being rotated relative to a desired orientation), and/or brackets to be used with particular teeth, and possibly to order brackets for treatment. Such automated methods are contemplated as being necessary to make the use of the large number of contemplated brackets manageable, to better insure proper treatment, and to minimize the amount of brackets that need to be kept in stock.

Still another aspect of the invention is the modification of tooth orientation without requiring that brackets be placed off-center on the labial surface or requiring that the amount of material used to bond a bracket to a tooth be modified from that used on other teeth.

Still another aspect of the invention is overcorrection of tooth orientation such that a tooth is rotated from an undesired orientation, through a desired orientation, to a second undesired orientation comprising tooth rotations opposite those found in the original orientation. Overcorrecting tooth orientation is contemplated to result in better retention as any initial tendency a tooth to move back towards its original orientation will in fact move it closer to a desired orientation. It is contemplated that four degrees of overcorrection may provide better long term orientation of teeth.

Yet another aspect of the invention is the use of two part brackets to obtain full or overcorrection of tooth orientation. Preferred brackets comprise a base having a deep

Fig. 13 is a top view of an image of a patient's teeth and arch.

Fig. 14 is a top view of a tapered archwire.

Fig. 15 is a top view of a square archwire.

Fig. 16 is a top view of an ovoid archwire.

Fig. 17 is a top view of a translucent sheet bearing representations of various different sized tapered archwires.

Fig. 18 is a top view of a translucent sheet bearing representations of various different sized square archwires.

Fig. 19 is a top view of a translucent sheet bearing representations of various different sized ovoid archwires.

Fig. 20A is a top view of a translucent sheet bearing archwire representations superimposed on a patient's study model to compare the representations to the patient's PIAC.

Fig. 20B is a top view of a translucent sheet bearing archwire representations being compared to the curve formed by the labial and buccal surfaces of a patient's teeth.

Fig. 21A is a dimensioned view of a small, tapered, lower archwire.

Fig. 21B is a dimensioned view of a medium, tapered, lower archwire.

Fig. 21C is a dimensioned view of a non-extraction, tapered, lower archwire.

Fig. 21D is a dimensioned view of a medium, square, lower archwire.

Fig. 21E is a dimensioned view of a large, square, lower archwire.

Fig. 21F is a dimensioned view of a small, ovoid, lower archwire.

Fig. 21G is a dimensioned view of a medium, ovoid, lower archwire.

Fig. 21H is a dimensioned view of a first non-extraction, ovoid, lower archwire.

Fig. 21I is a dimensioned view of a second non-extraction, ovoid, lower archwire.

Fig. 22A is a dimensioned view of a small, tapered, upper archwire.

Fig. 22B is a dimensioned view of a medium, tapered, upper archwire.

Fig. 22C is a dimensioned view of a non-extraction, tapered, upper archwire.

Fig. 22D is a dimensioned view of a medium, square, upper archwire.

Fig. 22E is a dimensioned view of a large, square, upper archwire.

Fig. 22F is a dimensioned view of a small, ovoid, upper archwire.

Fig. 22G is a dimensioned view of a medium, ovoid, upper archwire.

Fig. 22H is a dimensioned view of a first non-extraction, ovoid, upper archwire.

Fig. 22I is a dimensioned view of a second non-extraction, ovoid, upper archwire.

Fig. 23A is a perspective view of a properly aligned tooth.

Fig. 23B is top view of the tooth of figure 23A.

Fig. 23C is top view of the tooth of figures 23A and 23B shown with a mesial rotation.

Fig. 23D is top view of the tooth of figures 23A and 23B shown with a distal rotation.

Fig. 23E is top view of the tooth of figures 23A and 23B shown with a labial root rotation.

Fig. 23F is top view of the tooth of figures 23A and 23B shown with a lingual root rotation.

Fig. 23G is top view of the tooth of figures 23A and 23B shown with a mesial crown rotation.

Fig. 23H is top view of the tooth of figures 23A and 23B shown with a distal crown rotation.

Fig. 24 is an illustration of tooth position being divided into four quadrants.

Fig. 25 is a front view of a bracket comprising visual indicators.

Fig. 26 is an illustration of the torque components that a particular bracket might provide.

Fig. 27A is a top side view of a bracket.

Fig 27B is a right side view of the bracket of figure 27.

Fig. 27C is a bottom side view of the bracket of figure 27.

Fig. 27D is a left side view of the bracket of figure 27.

Fig. 27E is a side view of a bracket.

Fig. 27F is a side view of a bracket.

Fig. 27G is a front view of a bracket.

Fig. 27H is a front view of a bracket.

Fig. 27I is a front view of a bracket.

Fig. 27J is a front view of a bracket.

Fig. 28A is a perspective view of a multi-piece bracket assembly comprising a bracket and a slot insert.

Fig. 28B is a side, exploded view of the assembly of figure 28A.

Fig. 28C is a perspective view of the insert of figure 28A.

Fig. 28D is a side view of the bracket of figure 28A.

Fig. 29 is an illustration of a chart that can be used to identify mesially and distally rotated teeth.

Fig. 30 is a table identifying MS1 brackets.

Fig. 31 is a view of a patient characteristic form.

Fig. 32 is a view of a diagnosis assistance form.

Fig. 33 is a view of an appliance design form.

Fig. 34 is a view of a treatment history form.

Fig. 35 is a view of a patient picture presentation form.

Fig. 36 is a view of a window showing an enlarged view of a picture from the form of figure 35.

Detailed Description

GMPOI Holder

In figure 4, a preferred holder, positioning, and alignment apparatus 100 comprises a bracket holder 500, bracket/gripping member position and orientation indicator (hereinafter GMPOI) 600, and a bracket vertical position indicator/height gauge 700. Both GMPOI 600 and gauge 700 serve dual purposes as each can be used to both position and orient a bracket.

Referring to figures 4A-4H, holder 500 comprises a pair of elongated members 510 and 510' placed in an adjacent lengthwise relationship with one another, each member having a first end part 520 and 520' and a second end part 530 and 530', the first end part forming a gripping mechanism 540, and the second end parts coupled together to form a handle 550. As with the tweezers of figure 3, the holder 500 is a pre-tensioned or cross-over type having a gripping mechanism 540 comprising a jaw which is held in the closed position by tension formed by the shape of the tweezers, in particular by the cross-over portion 560. The

gripping jaw 540 includes the first end parts 520 and 520' of the members 510 and 510', includes gripping surfaces 570 and 570' having front edges 580 and 580' that are adapted for and used to grip the tie wings of an orthodontic bracket. The front edges 580 and 580' of the gripping jaws are inclined relative to a line L1 passing through the length of holder 500. In a preferred embodiment, a de-biasing portion 551 of either or both of members 510 and 510' is thinner than the remainder of the member so as to decrease the amount of force required to separate gripping surfaces 570 and 570'. In figure 4H thickness T2 is less than thickness T1, the thickness of a majority of member 510'. Holder 500 is preferably formed from elongated planar pieces of stainless steel.

It should be noted that the actual structure of holder 500 is not limited to that shown. Other contemplated embodiments of holder 500 will differ from the shown embodiment in regard to the materials used, form, and/or principle of operation. As would be obvious to one of average skill in the art, the methods and the position and orientation indicators disclosed herein are suitable for use with a large variety of holders.

Gripping member position and orientation indicator (GMPOI) 600 is preferably a planar member 610 with a parallelogram shape positioned between edges 580 and 580' and handle portion 550 as shown in figure 4F. It is preferred that member 610 be angled relative to the body of apparatus 100 such that the forward and rear edges 613 of the member are parallel with the edges 580 and 580' of holder 500. In figure 4F lines L3 and L4 illustrate the relative orientation of forward edge 613 and 580 in a preferred embodiment. As can be seen, lines L3 and L4 are parallel to each other, and are not perpendicular to the centerline L1 of holder 100. Member 610 preferably extends above and/or below the gripping surfaces 570 and 570', and more preferably above and/or below the handle portion 550. Member 610 is preferably positioned within 0.5 inches of the forward edges 580 and 580'. Member 610 is preferably perpendicular to the plane formed by edges 580 and 580'. Top and bottom edges 611 and 612 of member 610 are preferably parallel to the centerline of holder 100 as shown by lines L1 and L2 of figure 4F.

Preferred embodiments will comprise horizontal position indicators as well as vertical position indicators. In the embodiment shown, GMPOI 600 functions both as a position

indicator and an orientation indicator. However, it is contemplated that alternative embodiments may utilize separate and/or additional indicators.

Vertical indication indicator 700 comprises a height gauge formed by tooth occlusal surface contacting member 710, and height indication member 720 as shown in figure 4G. The distance D1' between members 710 and 720 is preferred to be fixed during formation of holder 100 and to correspond to a desired distance D1 to allow proper vertical positioning of bracket 10 relative to the occlusal plane P1. Members 710 and 720 are preferred to be parallel to each other. It is also preferred that edges 711 and 721 be adapted to fit within bracket's archwire receiving slots (see figures 8 and 9). Surface contacting member 710 is preferred to be substantially longer than surface contacting member 720 to permit member 710 to contact the occlusal surface of a tooth while edge 721 of member 720 is inserted into a bracket's archwire receiving slots.

In preferred embodiments member 720 will comprise a wire 722, possibly in the form of a loop, with edge 721 being a linear portion of wire 722. Forming edge 721 from wire 722 helps prevent inadvertent movement of a bracket when edge 721 is inserted into the bracket's archwire receiving slots, particularly when those slots are angles. With a wire, bracket holder 100 can rotate around edge 721 and have a minimal impact on a bracket during such a rotation. A tool which cannot be rotated around edge 721 that is inserted into an angled archwire receiving slot will itself be in a non-horizontal position, and thus cannot be used to accurately position the bracket because member 710 will be angled upward or downward.

It is preferred that member 710 be parallel to the line L5 formed by points 591 and 592, and be parallel to or coplanar with member 610. Points 591, the point at which members 510 and 510' cross, and 592, the center of the end of the handle portion of the holder, are readily identifiable when looking at apparatus 100. As such, points 591 and 592 provide a convenient means for using apparatus 100 to provide a visual indication of the orientation of members 710 and 610. Consequently, if either member 610 or 710 is inserted into a bracket's archwire receiving slots (as shown in figures 7 and 9), the line extending between points 591 and 592 provides an indication of the orientation of the bracket, and, because of the length of such a line, allows for finer adjustments to the orientation of a bracket than is possible by simply viewing the bracket while it is being gripped by the holder.

bracket installation. Figure 10 illustrates such a preloaded set of bracket holders 100A-100E pre-loaded with brackets 10A-10E. It is contemplated that preferred sets may comprise 20-24 holders, one for each of 20-24 brackets to be positioned. It is also contemplated that the brackets and holders of such a set may be arranged in an order related to the order in which the brackets are to be installed, or an order related to the relative positioning of the patients teeth so as to facilitate identification of the appropriate holder to use for each tooth.

It is contemplated that one method for using such a set for coupling a plurality of orthodontic brackets to a plurality of teeth would include providing a plurality of bracket holders, each holder having a grasping member adapted to receive and hold a bracket; providing a plurality of brackets; and, prior to coupling any one of the brackets to a tooth, causing each bracket holder to receive and hold a bracket. Such a method would preferably also include, prior to coupling any one of the brackets to a tooth, arranging the bracket holders in an order at least partially dependent on the order in which the brackets are to be installed, or at least partially dependent on the relative positions of the teeth to which the brackets are to be coupled.

Each patent or other publication referenced above is incorporated herein by reference in its entirety.

IP Archwire Sets

Referring to figure 11, a method of archwire selection comprises: step 1111, obtaining a representation of a patient's inner arch curve (a "PIAC"); step 1120, selecting an archwire shape based at least partially on the PIAC representation; step 1130, making an initial selection of an archwire size based at least partially on the PIAC representation; step 1140 selecting a final archwire size after considering something other than the PIAC representation; and step 1150, selecting an archwire to be used based on the selected archwire shape and selected final archwire size. Using the PIAC rather than the occlusal or labial and buccal surfaces of the teeth for archwire shape selection promotes shaping the teeth to the shape of the jaw bone and gives consistent facial esthetics plus better retention of the treatment correction.

A PIAC, as the term is used herein, is the curve formed by the jaw-bone structure of the patient. It is contemplated that the PIAC is best represented by the curve formed where

the surface formed by the patient's gums transitions from the surface formed by the portion of the gums covering the patient's upper or lower arch to the surface formed by the portion of the patient's gums covering the bases of the interior surfaces of the patient's teeth. As a patient has upper and lower arches, the PIAC corresponding to the upper arch will be referred to as the "upper PIAC", and the PIAC corresponding to the lower arch will be referred to as the "lower PIAC". In instances herein where what is being discussed can be applied to either or both the upper PIAC and lower PIAC, the acronym "PIAC" will not be preceded by either the word upper or lower. A similar convention will be followed in regard to the term "arch" as well. The PIAC will typically be visible if one views an image or study model of the patient's teeth and arch.

Referring to figures 12 and 13, obtaining a representation 1110 of the PIAC may be accomplished in a number of ways including but not necessarily limited to obtaining a study model 1100A of the patient's teeth and arch, obtaining an image 1100B of the patient's teeth and arch, and obtaining an electronic representation (not shown) of the patient's teeth and arch. Although the use of a study model 1100A or image 1100B is advantageous for manual selection methods, the use of alternative representations may be more advantageous for automated methods. If manual selection methods are to be used, it will generally be desirable that PIAC representation 1110 be visible. However, all that is required of a PIAC representation 1110 is that it be comparable to a representation of one or more archwires. As such, the type of representation used will be at least partially dependent on the manner in which comparisons are to be made.

Selecting an archwire shape will generally comprise comparing the PIAC representation 1110 to existing archwire shapes and selecting the archwire shape that most closely corresponds to the PIAC 1110. It is contemplated that a larger number of patients will have PIAC shapes that correspond to one of three archwire shapes, square, tapered, and ovoid. Figures 14-16 depict three archwires 1200 having the three shapes, square archwire 1210, tapered archwire 1220, and ovoid archwire 1230. It is contemplated that arch shapes other than those shown in figures 14-16 may be used, but that the three shown provide the best fit to reduce the manufacturing and inventory needed to use preformed shapes and sizes in private practice.

It is preferred that selection of an archwire shape be accomplished by comparing a representation of an available archwire to the PIAC representation 1110. The use of an archwire representation for comparison in place of an actual archwire is thought to advantageous, if not actually required, for use in automated archwire selection methods. The use of an archwire representation also provides advantages in manual selection methods as such a representation is generally cheaper than an actual archwire, maintaining the integrity of the representation is generally easier than doing the same for an archwire, and storing the representation is easier than storing the archwire. In less preferred methods, selection of an archwire shape may be accomplished by simply viewing the PIAC representation to determine its shape, the determined shape becoming the selected archwire shape.

Referring to figures 17-19, it is contemplated that, particularly for manual methods, providing one or more sets 1300 of archwire representations (1310A-1310C, 1320A-1320B, 1330A-1330D) on a transparent or translucent sheet 1301 facilitates selection of an archwire shape as the members of the collection can be visually compared to the PIAC by superimposing the individual archwire representations on the PIAC representation as shown in figure 20A. A given set may comprise representations of each shape of archwire, representations of different sized archwires of a given shape as was done in figures 17-19, or a combination of different archwire shapes and sizes. A given set may also include variations on sizes that correspond to treatment options such as non-extraction vs. extraction. Figure 17 shows a set 1300 of tapered shaped archwire representations 1310A-1310C, with 1310A being a small tapered archwire, 1310B being a medium tapered archwire, and 1310C being a non-extraction tapered archwire. Figure 18 shows a set 1300 of square shaped archwire representations 1320A-1320B, with 1320A being a medium square archwire, and 1320B being a large square archwire. Figure 19 shows a set 1300 of ovoid shaped archwire representations 1330A-1330D, with 1330A being a small ovoid archwire, 1330B being a medium ovoid archwire, 1330C being a first non-extraction ovoid archwire, and 1330D being a second non-extraction ovoid archwire.

Selecting an archwire size will generally comprise comparing the PIAC 1110 to existing archwire sizes (see figure 20A) and selecting the archwire size that most closely corresponds to the PIAC 1110. This initial selection will often be done simultaneously with the selection of the archwire shape by comparing various archwire representations to the

PIAC representation 1110. After an initial size selection is made, a final selection will be made based on criteria other than the PIAC 1110. Typically this will involve comparing various archwire representations with the curve 1120 formed by the outside (labial and buccal) surfaces of a patient's teeth (see figure 20B and figure 12) and determining which representation best corresponds to that curve. If a particular treatment option is to be chosen, the comparison may be limited to a subset of archwire sizes that correspond to the chosen treatment. Thus, on the same patient, one diagnosis (non-extraction) may require a larger size than the patient's original, naturally determined, arch size. In another treatment choice, the arch shape and size may be maintained, and in others, the shape and size may be constricted.

As an example, study model 1100A may be that of a patient who wants the wider smile that a non-extraction treatment could bring. Having obtained study model 1100A, a dentist would then pull out one or more transparent sheets 1301 bearing representations (1310-1330) of the archwires (1210-1230) available to the dentist. The dentist would first determine the appropriate archwire shape to be used by superimposing the different archwire representations on the study model to see which representation best fit the PIAC reproduced by the study model. For the sake of this example, we will assume that a small ovoid archwire best fits the patient's PIAC. Having determined the shape and that the final size will not be smaller than the small ovoid, the next step is to determine which size is appropriate. Since a non-extraction plan is to be followed, the small/first and medium/second non-extraction representations will be superimposed on the study model so that the dentist can visually determine which best fits the curve that will be formed when a wire is mounted to brackets coupled to the patient's teeth.

It is contemplated that the method of archwire selection discussed herein is particularly well adapted for implementation in an automated system 1400 for archwire selection as shown in figure 23. It is contemplated that such a system 1400 would beneficially comprise a patient internal arch curve 1410 recorder adapted to obtain a representation 1415 of a patient's internal arch curve; data 1420 on available archwires; and a mechanism 1430 adapted to compare an obtained representation 1415 of a patient's internal arch curve with the data 1420 on available archwires and to identify an archwire based on any such comparison. Such a system 1400 would also preferably include means 1440 for

accepting a treatment diagnosis 1450 for the patient. It is also preferred that either the curve recorder 1410 or some other means be used to provide additional data 1460 (such as current position, orientation, shape, and size) on the patients teeth. It is also preferred that such a system be integrated into a system 1500 (see figure 24) that facilitates the ordering of the selected archwire and other orthodontic hardware to minimize or eliminate the need for a dentist/orthodontist to stock archwires. Such a system will generally comprise means 1510 for selecting an archwire from a plurality of available archwires, and means 1520 for ordering the selected archwire from an archwire supplier. In such a system 1500, the selection of an archwire will likely be based, at least in part, on all of the following factors: the patient's jawbone structure; a dentists preferred treatment option; and the sizes and shapes of available archwires.

A patient internal arch curve recorder 1410 adapted to obtain a representation of a patient's internal arch curve 1415 may comprise a modern imaging system capable of providing the required electronic representation directly. Alternatively, such a recorder 1410 may simply comprise a scanner or digital camera which digitizes a representation (such as a study model or physical image) obtained through other means. Similar methods may be used to obtain additional data 1460 on the current state of the patient's teeth such as current position, orientation, shape, and size.

The data 1420 on available archwires is preferably a database of available archwires with sufficient data on each available archwire to permit comparison, primarily in regard to shape, with the patient's PIAC, the curve formed by the outside (labial and buccal) surfaces of the patients teeth, and the desired treatment option. In some instances, such data 1420 may be provided in electronic form directly from one or more archwire manufacturers. In other instances, such data may be obtained directly from examination of actual archwires.

A mechanism 1430 adapted to compare an obtained representation of a patient's internal arch curve 1415 with the data 1420 on available archwires may use one or more known comparison methods adapted for comparing curves and/or data sets. It is contemplated that such a mechanism 1430 may operate to identify an ideal curve based on the patients PIAC, the current state of the patient's teeth, the desired treatment option, and the next step to be performed in following that treatment option. Once such an idealized curve is

identified, it may be compared to the data available on available archwires to select an available archwire best adapted to accomplish the next step of the treatment. Alternatively, such a mechanism 1430 may simply plug all the data available on the patient and the available archwires into a complex algorithm that will identify the archwire to be used. Regardless of the method used, the results of the comparison need to be communicated to the dentist/orthodontist. It is preferred that the results be communicated directly to the dentist. The results may be communicated indirectly if the system is integrated with an ordering system such that the dentist is notified by receipt of an archwire, but such a system may be less than desirable if possible errors in treatment are to be minimized.

Any means 1440 for accepting a treatment diagnosis 1450 for the patient that facilitates the use of the diagnosis in selecting an archwire may be used. Such means 1440 will typically include the use of a keyboard and monitor to accept input and provide verification of correct input to the dentist. Alternatively, other means may be used such as systems designed to accept voice input and to provide audio confirmation and/or output.

Integration into a system 1500 that facilitates the ordering of the selected archwire and other orthodontic hardware is preferred in order to minimize or eliminate the need for a dentist/orthodontist to stock archwires. Ideally, the dentist/orthodontist would need to supply only a treatment diagnosis to the system, and facilitate the system's obtaining data on the patients teeth and jaw bone structure, confirm that an archwire or set of archwires is to be ordered, and then wait for delivery of the ordered archwire(s). Although stocking of some archwires may facilitate a just-in-time system of inventory in which inventory is replaced as used, it is preferred that little or no inventory of archwires be maintained and that archwires be obtained on an as-needed basis. Although there will generally be a delay between the determination of the archwire to be used and the dentists receipt of the archwire and/or use of it on the patient, such a delay is considered to be acceptable in light of the savings to be achieved by reducing or eliminating the dentist's inventory of archwires. Such a saving becomes even more significant as the number of shapes, sizes, and types of available archwires increases. Reference to figures 21A-21I and 22A-22I provide an indication of the impact of such an increase when one considers that in many instances a single archwire shape and size may have been previously used and stocked in place of the archwires shown.

Although the system and method discussed are generally applicable regardless of the archwire shapes and sizes available, it is contemplated that having the archwires shown in figures 21A-21I and 22A-22I may be advantageous. The pictured set of archwires is contemplated to be a set of archwires that embodies a desirable balance of the advantages and disadvantages relating to the number, size, and shape of archwires available. It is contemplated that the archwires shown may also comprise T and/or keyhole loops and or loops having other shapes. In such instances the pictured archwires would be illustrative of the shape of such archwires as viewed with any such loops projecting directly into or out of the page.

Orientation Correction

Treatment of tooth orientation is preferably begun by identifying mis-oriented (those having undesired orientations) teeth in regard to the types of rotations that would be required to rotate each of such teeth form its proper orientation to its actual orientation. Particularly if being done in conjunction with correction of tooth position, such identification is preferably done prior to beginning treatment or early during treatment in a manner to be described. After identifying mis-oriented teeth, tooth orientation is preferably corrected through the use of rotation brackets such as those described further on. It is contemplated that the use of brackets adapted to provide particular types of correction will minimize or eliminate the need for wire bending during treatment. The use of rotation brackets during treatment is best accomplished if a bracket be selected for every tooth having (or that will have) an undesired orientation where the bracket is adapted to apply torque to the tooth to cause it to rotate towards a desired orientation. During treatment, the identification methods described can be used to very that correction of orientation is occurring and/or is complete.

In many instances, treatment of tooth orientation will preferably involve overcorrection of tooth orientation to achieve better retention. Overcorrecting tooth orientation involves rotating a tooth from an undesired orientation, through a desired orientation, to a second undesired orientation comprising tooth rotations opposite those found in the original orientation. If overcorrected, any initial tendency for a tooth to move back towards its original orientation will in fact move it closer to a desired orientation. It is contemplated that four degrees of overcorrection may provide better long term orientation of teeth.

Orientation and Torque

The orientation of a particular tooth can be described as one or more rotations about at least one of three orthogonal axis intersecting at the center of the tooth. Axis A1, A2, and A3 in figure 23A are an example of such axis. A tooth can be characterized as having the following "surfaces" (each "surface" being a portion of the exterior surface of the tooth as illustrated in figures 23A and 23B): mesial 2201, distal 2202, lingual 2203, labial 2204, and occlusal 2205, and can also be characterized as including a crown 2206 and a root 2207. The portions of a tooth 2200 corresponding to such surfaces are illustrated in figures 23A and 23B. In some instances a given surface will be referred to by its name alone such as "the mesial" rather than "the mesial surface". The various surfaces of a tooth are determined by where the surfaces would be on a properly aligned tooth (as shown in figures 23A and 23B) rather than where they actually are. Figure 23C illustrates the location of the various surfaces (2201-2204) for the tooth 2200 of figures 23A and 23B assuming tooth 2200 has been rotated around axis A1. The arrow drawn on the occlusal surface 2205 of tooth 2200 points to the same point on tooth 2200 in both figures 23B and 23C to help illustrate the 90 degree rotation of tooth 2200 around axis A1 between figures 23B and 23C. Also shown in figures 23A-23C are line J1 indicating the curve that would normally be formed by other teeth and area B1 which indicates a preferred mounting position for a bracket, i.e. in the center of labial surface 2204. In contrast, the "facial surface" 2208 of a tooth is used to refer to the portion of the tooth closest to the face (i.e. the position of the labial surface in a non-rotated tooth) for both rotated and non-rotated teeth. The facial surface is also the portion of a tooth closest to an unbent, shaped archwire positioned adjacent the teeth.

A tooth rotated from its proper/desired orientation around axis A1, such as tooth 2200 in figure 23C, can be described in relation to how the actual position of the labial surface 2204 (or area B1) relative to its proper position. As an example, tooth 2200 in figures 23C can be described as having a mesial rotation as labial surface w204 is rotated around axis A1 towards the proper position of mesial surface w201. If, as shown in figure 23D, labial surface 2204 had been rotated in an opposite direction around axis A1, tooth 2200 could be described as having a distal rotation because the labial surface would be rotated around axis A1 towards the proper position of the distal surface 2202. Correcting for mesial rotation

would require application of distal torque and correcting for distal rotation would require application of mesial torque.

A tooth rotated from its proper orientation around axis A2, such as tooth 2200 in figure 23E or figure 23F, can be described in relation to the position of the occlusal surface 2205 relative to the tongue or lips. If tooth 2200 is rotated around axis A2 as shown in figure 2E such that occlusal surface 2205 is rotated towards the tongue, tooth 2200 may be described as having lingual rotation. Similarly, if tooth 2200 is rotated around axis A2 as shown in figure 23F such that occlusal surface 2205 is rotated towards the lips, tooth too may be described as having labial rotation. To help distinguish rotations around axis A2 from those of axis A1 and A3, rotations around axis A2 may be described as "labial root rotation" and "lingual root rotation". Correction for lingual root rotation would require application of labial torque (sometimes referred to as "labial root torque"), and correcting for labial root rotation would require application of lingual torque (sometimes referred to as "lingual root torque").

A tooth rotated from its proper orientation around axis A3, such as tooth 2200 in figure 23G or figure 23H, can be described in relation to the position of the occlusal surface 2205 or crown 2206 relative to mesial or distal surfaces. If tooth 2200 is rotated around axis A3 as shown in figure 23G such that crown 2206 is rotated towards the mesial, tooth 2200 may be described as having mesial angulation, mesial crown angulation, or mesial crown rotation. The phrase "mesial rotation" is not used because of the possibility of confusion with a rotation around axis A1. Similarly, if tooth 2200 is rotated around axis A2 as shown in figure 23H such that crown 2206 is rotated towards the distal, , tooth 2200 may be described as having distal angulation, distal crown angulation, or distal crown rotation. The use of "distal rotation" is preferably limited to rotations around axis A1.

Having brackets adapted to apply torque to a tooth to cause it to rotate towards a desired orientation requires a larger number of different types of brackets than is typically used. In addition to having variations based on the types of rotations to be corrected for, there will preferably be variations based on positions of teeth within the mouth. Referring to figure 24, each tooth in a persons mouth can be characterized as being in one of four quadrants Q1-Q4. The teeth shown in figure 24 are shown as if one were looking outward

from inside a person's mouth. In figure 24, quadrant Q1 is the upper right quadrant, Q2 is the upper left quadrant, Q3 is the lower left quadrant, and Q4 is the lower right quadrant.

Bracket Indicators

Having a large variety of brackets makes it advantageous to provide visual indicators on the brackets to help identify the tooth position and correction associated with each bracket. Such indicators would provide the person selecting the bracket with an indication as to which bracket is appropriate for a desired task. Preferred brackets will comprise indicators that indicate both the quadrant of teeth it is appropriate for and the type of correction it provides. The type of correction is preferably specified either in regard to the type of rotation use of the bracket will cause, or the type of tooth rotation it corrects, or some combination thereof.

A preferred set of indicators comprises a set of three colored dots painted or otherwise applied to a bracket's surface, and more preferably to the wing ties. A preferred bracket using three colored indicator dots (2425A-2425C) is shown in figure 25. In figure 25, bracket 2420 comprises base 2421, and stems 2422 and 2423. Stems 2422 and 2423 each comprise two tie wings (2422A, 2422B, 2423A, and 2423B) and an archwire receiving slot (2422C and 2423C). For the bracket 2420 of figure 25, tie wings 2422A and 2422B are mesial tie wings and 2423A and 2423B are distal tie wings, brackets 2423A and 2424A are occlusal tie wings and brackets 2423B and 2224B are gingival tie wings. Dot 2425A on the distal gingival tie wing preferably indicates the quadrant the bracket is appropriate for with black indicating upper right quadrant Q1, green indicating upper left quadrant Q2, white indicating lower left quadrant Q3, and red indicating lower right quadrant Q4. Dots 2425B and 2425C are used in conjunction to indicate the tooth of correction provided. Correction relative to axis A1 is preferably indicated in relation to the orientation of the tooth to which it is to be applied with red indicating the bracket is for use with a tooth having mesial rotation and green indicating the bracket is for use with a tooth having distal rotation. Correction relative to axis A2 is indicated based on the type of torque the bracket will apply to the tooth with black indicating that the bracket will apply linqual root torque and white that it will apply labial root torque. A yellow dot is used to indicate that the bracket provides correction for distal crown angulation. As an example, a bracket suitable for use on an upper right quadrant tooth having mesial rotation and needing labial root torque would have black on the distal-gingival tie wing (dot 2425A) indicating that the bracket is for the upper right quadrant,

and red and white dots on the mesial tie wing (dots 2425B and 2425C) to designate the mesial rotation and labial root torque. It is contemplated that non-combination brackets (brackets that do not provide for rotations about multiple axis) may have fewer dots than combination brackets (brackets that do provide for rotations about multiple axis).

Rotation Brackets - General

As shown in figure 26, the torque T a given bracket applies to a tooth it is mounted on when coupled to an archwire can be described as the sum of several component torques such as a combination of torques T1-T6 about axis A1-A3. It is preferred that mounting brackets be positioned in the center of the facial surface of each tooth rather than offsetting the position of the brackets to apply torque to a tooth. As such, torques T1-T2 are preferably obtained by angling the base surface of the archwire receiving slot such that one side of the slot is effectively deeper than the other side of the slot as shown in figures 27A-27D, or, less preferably, by making one side/tie wing higher than the other. It is contemplated that angling the base of the slot can be accomplished simply by cutting one side of the slot deeper than the other, or, more preferably, through the use of a multi-piece bracket assembly comprising a bracket and a slot insert. Referring to figures 27E and 27F, torques T5 and T6 are obtained by making one side of the archwire receiving slot (or buccal tube) higher than the other. Alternatively, a bracket adapted to provide no torque or one or more of torques T1-T4 may be mounted as shown in figure 27G and 27G to achieve the same affect. It is contemplated that the bracket holder described hrein is particularly well adapted for mounting brackets in such a fashion as it include a visual indicator that helps determine/set the orientation of the bracket. Referring to figures 27I –27K, torques T3-T4 are possibly obtained by angling the tie wings and archwire receiving slot (or buccal tube) relative to the base such that the archwire receiving slot (or buccal tube) will not be parallel to a tooth's occlusal surface when coupled to a tooth and/or the lower and upper wings are at different heights relative to the base of the bracket and surface of a tooth to which it is mounted.

In many instances treatment causes the crowns of teeth to move outward as the crowns are not anchored as the roots are. It is contemplated that this tendency can be countered using brackets adapted to apply labial root torque, i.e. a torque that tends to rotate the roots of a tooth towards the patient's lips and the crown of the tooth towards the interior of the patient's mouth. The bracket of figures 27J and 27K are particularly well adapted for

this purpose as the angle of the slot will require a slight twist in an archwire being inserted into it. In such an instance the archwire is biased to try and untwist and, in that manner, applies the desired torque to a tooth.

It is contemplated that the use of brackets adapated in the described manner will eliminate or decrease the need to place brackets off-center on the labial surface or requiring that the amount of material used to bond a bracket to a tooth be modified from that used on other teeth in order to modify tooth orientation.

Rotation Bracket – Multi-piece Assembly

Referring to figure 28A-28D, a preferred bracket assembly comprises a bracket 2720 and an archwire receiving slot insert 2750 inserted into slot 2724 of bracket 2720. The bracket 2720 and insert 2750 are part of a multi-part bracket assembly adapted to apply torque to a patient's tooth so as to obtain full or overcorrection of tooth orientation. Slot 2724 is preferably cut deeper than slots of standard bracket so as to allow room for insertion of insert 2750.

Insert 2750 preferably comprises a wedge shape, the wedge being formed from two surfaces 2751 and 2752 angled relative to each other where surface 2752 is adapted to conform to the base/bottom surface 2724C of the slot 2724. The slot insert 2750 is preferably inserted into the slot prior to the slot receiving an archwire, and to be at least partially held in place by such an archwire once the archwire is tied in place. It is contemplated that, once tied, the archwire will hold the insert 750 in place and will also cover insert 2750 so as to hide it from view and maintain any aesthetic qualities of the bracket. Insert 2750 preferably also comprise lips/collars 2753 and 2754 that project outward from surface 2752 to deter insert 2750 from sliding along surface 2724C of slot 2724 once positioned within slot 2724. Insert 2750 preferably also comprises a removable tab 2755 adapted to facilitate handling of insert 2750 during its placement within slot 2724. In preferred embodiments tab 2755 will extend outward from one end of insert 2750, will be circular, and/or will be easily separated from the rest of insert 2750 once insert 2750 has been inserted into slot 2724.

Bracket 2720 preferably comprises a contoured base surface 2727 adapted to be bonded to a tooth, the contour of surface 2727 being such as to better conform to the shape of the surface of a tooth to which it is being mounted than would a flat base surface. In

preferred embodiments, base surface 2727 is at least partially cylindrical and has a radius of R inches. Bracket 2720 preferably also comprises grooves 2725 or other features that reduce the area of surface 2727 such that the bonding characteristics of bracket 2720 are similar as those for metal appliances.

Bracket 2720 may be debonded from a tooth of a patient by having the patient bite on something such as a cotton roll, and then grabbing the mesial and distal surfaces of the bracket with a bracket debonding pliers and twisting/torquing the bracket to remove it. Once removed, any residual ceramic is accomplished with a diamond bur in a rotary handpiece or by some other suitable method.

Identification and Recordation of Rotated Teeth

Identification of rotated teeth (i.e. mis-oriented teeth) and comparison of current tooth orientation to a desired orientation may be facilitated through the use of shaped archwires such as those previously described herein. As previously indicated, a tooth having a desired orientation has no rotation about any of axis A1-A3 and thus has the labial surface as the facial surface. By holding a shaped archwire adjacent to a patients teeth (or a study model of a patients teeth, or by comparing an overlay to such a study model) and determining whether the facial surface of a tooth comprises portions of the mesial or distal surfaces, the tooth can be classified as having mesial or distal rotation. In many instances, careful comparison will show the existence of rotations that would not otherwise be detected. Such a comparison may be accomplished manually or via automated means. If automated means are used it is contemplated that a representation of a patient's teeth will be made, at least one of the mesial or distal surfaces identified for each tooth, that a determination will be made as to the position or orientation of such identified surface relative to its proper position/or orientation or relative to the position of a shaped archwire located adjacent to the teeth, that each tooth will be classified based on its orientation and the quadrant it is poistioned in, and that such classification will be used to identify the bracket to be used for each tooth.

In some instances manual and/or automated means may also be used to determine tooth orientations/unwanted rotations anticipated to result from a selected treatment and to identify brackets to be used to prevent occurrence of such unwanted rotations. Thus if movement of a tooth from a first position to a second position using a standard bracket (i.e.

one that doesn't provide any rotation corrections) would result in unwanted rotation of the tooth such that the tooth ends up in the desired position with an undesired orientation, a bracket adapted to correct for the anticipated rotation may be used to insure that the tooth ends up in the desired position with a desired orientation. Due to the factors involved it is contemplated that selecting brackets to prevent undesired rotations is best accomplished via automated means. Whether done manually or via automated means, it is contemplated that bracket selection will be based on a combination of current tooth position and orientation, desired tooth position and orientation, and the treatment to be used to move the tooth from its current position and orientation to its desired position and orientation.

Particularly if automated means are used for bracket selection, it is contemplated that the increasing the number of brackets available for use, where each bracket is adapted to provide a certain amount of correction to a tooth's orientation, increases the number of treatment options available as well as the quality of the treatment obtained.

To facilitate identifying and recording mis-oriented teeth, it is preferred that individual teeth be identified by numbers comprising two digits with the first digit identifying the quadrant a tooth is located in, and a second digit identifying the position of the tooth relative to the middle and front of the jaw it is attached to. As such, teeth located in the first quadrant may be numbered 11-17 with 11 corresponding to the tooth in the quadrant closest to the middle and front of the jaw, 12 the tooth adjacent to tooth 11 in the quadrant, with the series continuing to tooth 17 being the tooth in the quadrant having the largest number of teeth between it and tooth 11. Teeth in quadrant 2 will be similarly numbered as 21-27, teeth in quadrant three as 31-37 and teeth in quadrant four ad 41-47. Using such numbers to identify teeth, the chart of figure 29 chart may be used to record whether particular teeth are mesially or distally rotated:

Bracket Identification

It is preferred individual brackets be identified by the tooth number to which it applies, and a suffix. Contemplated suffixes include suffixes beginning with the letter M to indicate brackets suitable for correction of teeth that have a mesial rotation, and the letter D to indicate brackets suitable for correction of teeth that have a distal rotation. The upper case letter D or M may be followed additional letters or digits as shown in the following table:

Suffice	Meaning
s	The bracket has a small bonding pad.
2	The bracket is welded to a band rather than adapted to being bonded directly to a tooth.
2tipDc	The bracket is welded to the crown with a distal crown tip. (i.e. The bracket is tipped, preferably 4 degrees, relative to the band it is welded to such that the portion of the bracket closest to the crown is tilted toward the distal surface of the tooth.)
2tipM	The bracket is welded to the crown with a mesial crown tip. (i.e. The bracket is tipped, preferably 4 degrees, relative to the band it is welded to such that the portion of the bracket closest to the crown is tilted toward the mesial surface of the tooth.)
li	The bracket has added lingual root torque.
la	The bracket has added labial root torque.

In some instances, suffixes that don't begin with M or D will be used. Some such contemplated suffixes include:

CIIE	A bracket designed for use with class II elastics.
CIIE2	A bracket designed for use with class II elastics that is welded to a band.
Up	A molar uprighting bonded bracket.
Up2c	A molar uprighting bonded bracket welded to a band.

Preferred Bracket Sets

It is preferred that the treatments be determined selecting an incorporating the use of one or more of a set of preferred brackets. Such a set preferably comprises one or more of the brackets described below of in the table of "MS1" brackets of figure 30. The set of brackets described will sometimes be described herein as McGann Series 1 brackets or alternatively as MS1 brackets. Each MS1 bracket is identified using the identifications listed above, with the description including comments under what treatment circumstances each rotations bracket may be advantageously used.

MS1 "mesial rotation brackets" are brackets suitable at least for (a) correction of teeth that have a mesial rotation, or (b) preventing unwanted rotation that can result from applying open coil force to the distal of the bracket as is common in the alignment stages. MS1 mesial

rotation brackets provide 4 degrees of overcorrection to eliminate finishing bends and to improve the retention experience.

MS1 "distal rotation brackets" are brackets suitable at least for (a) correction of teeth that have a distal rotation, or (b) preventing unwanted rotation that can result from applying open coil force to the mesial of the bracket as is common in the alignment stages. MS1 distal rotation brackets provide 4 degrees of overcorrection to eliminate finishing bends and to improve the retention experience.

Upper Quadrant Brackets

A "16D" bracket is a convertible bonded bracket without distal offset for use in class III cases where class III elastics is the main method to correct the occlusion. The lack of distal offset creates mesial-palatal rotation of the upper molars, favorable when correcting class III dental. The tube can be converted to a bracket to allow for the placement of finishing bends between the first and second molars and/or to engage heavy rectangular archwires to the second molar.

A "15M" bracket is a mesial rotation bonded bracket with a mesial hook and an offset bonding pad. This variation is critical in pre-implant preparation with open coils as the mesial rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation. Another use of this variation is in cases with excess spacing and minimum anchorage. Mesial forces applied to the bracket tend to create a rotation of the bicuspid, which can be compensated by the extra counter-rotation in the bracket.

A "15Ms" bracket is a mesial rotation bonded bracket with mesial hook and small bonding pad. Used on mesial rotated teeth with short clinical crowns, where the standard offset pad is too large for the tooth. Four (4) degrees of mesial over-correction has been added to the archwire slot. This bracket may also be used when applying open coil force to the distal of the bracket, as is common in molar uprighting cases, but a band may be better in such cases to reduce bracket debonding. Using this variation is critical in pre-implant preparation with open coils. The mesial rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation. Another use of this variation is in cases with excess spacing and minimum anchorage. Mesial forces

applied to the bracket tend to create a rotation of the bicuspid, which can be compensated by the extra counter-rotation in the bracket.

A "15M2" bracket is a mesial rotation bracket welded to a band with a mesial hook and no lingual cleat. Used on teeth with "mesial rotations" that have short clinical crowns, and where heavy forces are to be applied to the tooth. Four (4) degrees of overcorrection is added to the bracket slot to eliminate finishing bends and to improve the retention experience. When applying open coil force to the distal of the bracket, as is common in molar uprighting cases, a band may be better to reduce bracket debonding. For pre-implant preparation of upper 6s with open coils, it may be better to use the variation with a weld variation (15M2tipD) to also control the root angulation. The mesial rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation. Use this variation in cases with excess spacing and minimum anchorage. Mesial forces applied to the bracket tend to create a rotation of the bicuspid, which can be compensated by the extra counter-rotation in the bracket. Bands may also be preferred when porcelain or gold crowns must be bracketed. The band does not break the glaze of the porcelain, although care must be exercised when removing bands from porcelain crowns to avoid fracturing the porcelain (slit the band with a bur).

A "15M2tipDc" bracket is a welded variation of a "mesial rotation" bracket. The bracket is welded to a band with an added 4 degrees of distal crown tip when a straight wire is engaged. These features make this variation especially important in the pre-prosthetic preparation for upper 6-replacement with an implant or fixed bridge. When applying open coil from 7-5, it is common for the crown to move mesial, but the root does not remain parallel. The forces applied away from the center or rotation of the tooth creates unwanted tipping. Lack of root parallelism or proper control of the palatal cusp can be a problem in creating an ideal restorative replacement.

The mesial rotation is used to compensate for the forces applied to the distal surface of the bracket, creating a rotation of the bicuspid. A cleat is standard on this variation as lingual mechanics are often required to further control the position of the palatal cusp. Bands may also be preferred when porcelain or gold crowns must be bracketed. The band does not

break the glaze of the porcelain, although care must be exercised when removing bands from porcelain crowns to avoid fracturing the porcelain (slit the band with a bur).

A "15D" bracket is a distal rotation bonded bracket with mesial hook and an offset bonding pad. This variation should be also used whenever open coil or chain will be applied to the mesial surface of the bicuspid, as is common in class II distalization cases. The added rotation will compensate for the forces being applied away from the center of rotation of the bicuspid. This bracket could also be used for bicuspid distalization into edentulous spaces, although the 15D2tipM is better designed for this purpose.

A "15Ds" bracket is a distal rotation bonded bracket with a mesial hook and a small bonding pad. Used on teeth with short clinical crowns, where the standard offset pad is too large for the tooth. This variation is used on teeth with "distal rotations", adding 4 degrees of overcorrection to avoid finishing bends and early correction of the rotation for an improved retention experience. This bracket could also be used when applying open coil force to the mesial of the bracket, as is common when opening the first bicuspid space. The distal rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation. Another use of this variation is for class II distalization cases where a significant amount of retraction is needed to correct the class II. The retraction forces applied to the bracket would tend to create a rotation of the bicuspid, which can be compensated by the counter-rotation in the bracket.

A "15D2" bracket is a distal rotation bracket welded to a band with a mesial hook and no lingual cleat. Used on teeth with distal rotations, short clinical crowns, and where heavy forces are to be applied to the tooth. By adding 4 degrees of over-correction, the rotation can be fully corrected, eliminating the need for finishing bends. When applying heavy (stainless steel) open coil force to the mesial of the bracket, as is common when opening first bicuspid space, a band may be better to reduce bracket debonding. For pre-implant preparation of upper 4s with open coils, it may be better to use the variation with a weld variation (15D2tipM) to also control the root angulation. The distal rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation. Also apply this variation to severe class II cases where significant retraction of the bicuspid is planned. The retraction forces, when applied to the bracket, tend to create a rotation of the

bicuspid, which can be compensated by the counter-rotation in the bracket. Bands may also be preferred when porcelain or gold crowns must be bracketed.

A "15D2tipM" bracket is a distal rotation bracket welded to a band with 4 degrees of mesial crown tip when a straight archwire is engaged. This variation is especially helpful in the pre-prosthetic preparation for implants (replacing upper 4), bridges, or for bicuspid distalization cases to maintain root parallelism at the same time compensating for the distal forces being applied to the buccal surface of the tooth. The distal rotation feature compensates for the forces being applied to the mesial of the bracket. The standard mesial ball hook can be used for vertical elastic application. Bands are generally preferred when porcelain or gold crowns must be bracketed.

A "15D2" bracket is a distal rotation bracket welded to a band with a mesial hook and no lingual cleat. Used on teeth with distal rotations, short clinical crowns, and where heavy forces are to be applied to the tooth. By adding 4 degrees of over-correction, the rotation can be fully corrected, eliminating the need for finishing bends. When applying heavy (stainless steel) open coil force to the mesial of the bracket, as is common when opening first bicuspid space, a band may be better to reduce bracket debonding. For pre-implant preparation of upper 4s with open coils, it may be better to use the variation with a weld variation (15D2tipM) to also control the root angulation. The distal rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation. Also apply this variation to severe class II cases where significant retraction of the bicuspid is planned. The retraction forces, when applied to the bracket, tend to create a rotation of the bicuspid, which can be compensated by the counter-rotation in the bracket. Bands may also be preferred when porcelain or gold crowns must be bracketed.

A "15D2tipM" bracket is a distal rotation bracket welded to a band with 4 degrees of mesial crown tip when a straight archwire is engaged. This variation is especially helpful in the pre-prosthetic preparation for implants (replacing upper 4), bridges, or for bicuspid distalization cases to maintain root parallelism at the same time compensating for the distal forces being applied to the buccal surface of the tooth. The distal rotation feature compensates for the forces being applied to the mesial of the bracket. The standard mesial

ball hook can be used for vertical elastic application. Bands are generally preferred when porcelain or gold crowns must be bracketed.

A "14M" bracket is a mesial rotation bonded bracket with a mesial hook and an offset bonding pad. Used on teeth with "mesial rotations", providing 4 degrees of overcorrection to eliminate finishing bends and to improve the retention experience. This bracket would also be used when applying open coil force to the distal of the bracket, as is common when opening the upper second bicuspid space. Using this variation would be critical in pre-implant preparation with open coils. The mesial rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation. This variation would also be used in cases with excess spacing and minimum anchorage. Mesial forces applied to the bracket would tend to create a rotation of the bicuspid, which can be compensated by the counter-rotation in the bracket.

A "14Ms" is a mesial rotation bonded bracket with a mesial hook and a small bonding pad. Used on teeth with short clinical crowns, where the standard offset bonding pad is too large for the tooth. This variation is used on teeth with "mesial rotations", providing 4 degrees of overcorrection to eliminate finishing bends and to improve the retention experience. This bracket may also be used when applying open coil force to the distal of the bracket, as is common when opening upper second bicuspid spaces, but a band may be better in such cases to reduce bracket debonding. Using this variation would be critical in pre-implant preparation with open coils. The mesial rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation. This variation would also be used in cases with excess spacing and minimum anchorage. Mesial forces applied to the bracket would tend to create a rotation of the bicuspid, which can be compensated by the extra counter-rotation in the bracket.

A "14M2" is a mesial rotation bracket welded to a band with a mesial hook and no lingual cleat. Used on teeth with short clinical crowns, and where heavy forces are to be applied to the tooth. This variation is used on teeth with "mesial rotations", providing 4 degrees of overcorrection to eliminate finishing bends and to improve the retention experience. Full correction of rotations early in treatment, rather than in the finishing stage, results in more stability in retention. When applying open coil force to the distal of the

bracket, as is common when opening upper second bicuspid space, a band may be better to reduce bracket debonding. For pre-implant preparation of upper 5s with open coils, it may be better to use the variation with a weld variation (14M2tipD) to also control the root angulation. The mesial rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation. Also use this variation in cases with excess spacing and minimum anchorage. Mesial forces applied to the bracket will tend to create a rotation of the bicuspid, which can be compensated by the counter-rotation in the bracket. Bands may also be preferred when porcelain or gold crowns must be bracketed.

A "14M2tipDc" is a mesial rotation bracket welded to a band with an added 4 degrees of distal crown tip when a straight wire is engaged. This variation is especially important in the pre-prosthetic preparation for upper second bicuspid (5) replacement with an implant or fixed bridge. When applying open coil from 6-4, it is common for the crown to move mesial, but the root tips. The forces applied away from the center or rotation of the tooth cause this loss of root parallelism. Lack of root parallelism, and/or proper control of the palatal cusp can be a problem in creating an ideal restorative replacement.

The mesial rotation is used to compensate for the forces applied to the distal surface of the bracket, creating a rotation of the bicuspid. A cleat is standard on this variation as lingual mechanics are often required to further control the position of the palatal cusp. Bands may also be preferred when porcelain or gold crowns must be bracketed. The band does not break the glaze of the porcelain, although care must be exercised when removing bands from porcelain crowns to avoid breaking the porcelain (slit the band with a bur).

A "14D" bracket is a distal rotation bonded bracket with a mesial hook and an offset bonding pad. Used on teeth with "distal rotations", adding 4 degrees of overcorrection to avoid finishing bends and allowing early correction of the rotation for an improved retention experience. Correcting rotations in the finishing stage is both time-consuming and unstable in retention. This variation should also be used whenever open coil or chain is applied to the mesial surface of the bicuspid, as is common in class II distalization cases. The added rotation will compensate for the forces being applied away from the center of rotation of the bicuspid. This bracket could also be used for bicuspid distalization into edentulous spaces, although the 14D2tipM is better designed for this purpose.

A "14Ds" bracket is a distal rotation bonded bracket with a mesial hook and a small bonding pad. Used on teeth with short clinical crowns, where the standard offset pad is too large for the tooth. This variation is used on teeth with "distal rotations", adding 4 degrees of overcorrection to avoid finishing bends and allow early correction of the rotation for an improved retention experience. Correcting rotations in the finishing stage is both-time consuming and unstable in retention.

This bracket can also be used when applying open coil force to the mesial of the bracket, as is common when opening the cuspid space. The distal rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation.

This variation should also be used in class II distalization cases with a significant amount of retraction needed to correct the class II. The retraction forces applied to the bracket would tend to create a rotation of the bicuspid, which can be compensated by the counter-rotation in the bracket.

A "14D2" bracket is a distal rotation bracket welded to a band with a mesial hook and no lingual cleat. Used on teeth with short clinical crowns, and where heavy forces are to be applied to the tooth. This variation is used on teeth with "distal rotations", adding 4 degrees of overcorrection to avoid finishing bends and early correction of the rotation for an improved retention experience.

When applying heavy (stainless steel) open coil force to the mesial of the bracket, as is common when opening space for a blocked out cuspid, a band may be better to reduce bracket debonding. For pre-implant preparation of upper 5s with open coils, it may be better to use the variation with a an offset weld (14M2tipD) to also control the root angulation. The distal rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation.

Use this variation in severe class II cases where significant retraction of the bicuspid is planned. Retraction forces, when applied to the bracket, tend to create a rotation of the bicuspid, which can be compensated by the distal counter-rotation in the bracket. Bands may also be preferred when porcelain or gold crowns must be bracketed.

A "14D2tipM" bracket is a distal rotation bracket welded onto a band with 4 degrees of mesial crown tip when a straight archwire is engaged. This "combination" variation is especially helpful in the pre-prosthetic preparation for implants (replacing upper 3), bridges, or for bicuspid distalization cases to maintain root parallelism. The distal rotation feature compensates for the forces being applied to the mesial of the bracket, typically creating a rotation of the bicuspid. The standard mesial ball hook can be used for vertical elastic application. Bands may also be preferred when porcelain or gold crowns must be bracketed.

A "13M" bracket is a mesial rotation bracket used on upper right cuspids with "mesial rotations", providing 4 degrees of overcorrection to eliminate finishing bends and to improve the retention experience. The hook is on the distal, reducing distal-lingual rotation from elastic and coil forces applied away from the center of rotation.

Mesial rotation brackets may also be used to compensate for the rotation tendency of open coil applied to the distal of the tooth, as when upper first bicuspid (4) space is opened. When open coil is applied to the mesial of the bracket, opening space between the 2 and 3, a distal rotation bracket would be used to compensate. If the cuspid has a mesial rotation, and is scheduled for retraction, use the mesial rotation bracket. This will provide some over-correction of the rotation as the canine is retracted.

A "13D" bracket is a distal rotation bracket applied to teeth with "distal rotations", adding 4 degrees of overcorrection to avoid finishing bends and early correction of the rotation for an improved retention experience. Correcting rotations in the finishing stage is both time-consuming and unstable in retention. In cases where stainless steel open coil is applied to the mesial of the bracket, such as opening space to retrieve upper 2s blocked out in the palate, this variation should be used to compensate for the rotation tendency.

A "12M" bracket is a mesial rotation bracket used on teeth with "mesial rotations", providing 4 degrees of overcorrection to eliminate finishing bends and to improve the retention experience. Correcting rotations with finishing bends in stainless steel archwires is time-consuming and inefficient. Mesial rotation brackets may also be used to compensate for the rotation tendency as open coil is applied to the distal of the tooth, as when upper cuspid (3) space is opened.

A "12D" bracket is a distal rotation bracket used on teeth with "distal rotations", adding 4 degrees of overcorrection to avoid finishing bends and to provide early correction of rotations for an improved retention experience. Be certain to view the study model with the archwire overlay to determine if the tooth is rotated, as some teeth appear straight when they are not.

A "12Mli" bracket is a combination bracket having added lingual root torque (torque 14) for use on retroclined incisors and/or incisors that are to be retracted a significant amount. In addition, this bracket has a "mesial rotation" of 4 degrees for the early full correction of the rotation, eliminating finishing bends, and improving the retention experience.

A "12Dli" bracket is a combination bracket having added lingual root torque (torque 14) for use on retroclined incisors and/or incisors that are to be retracted a significant amount. In addition, a "distal rotation" of 4 degrees has been added to avoid finishing bends and for full correction of the rotation early in treatment, improving the retention experience.

A "12Mla" bracket is a combination bracket having added labial root torque (-2) and mesial rotation of 4 degrees. Use this variation in class III cases to limit upper incisor proclination AND when the incisors have a mesial rotation. This bracket is also used for the palatal positioned lateral incisors to bring the root forward as the crown is aligned, PLUS add over-correction to a mesial rotation.

A "12Dla" bracket is a combination bracket having added labial root torque (-2) and distal rotation of 4 degrees. Use this variation in class III cases to limit upper incisor proclination AND when the incisors have a distal rotation. This bracket is also used for the palatal positioned lateral incisors to bring the root forward as the crown is aligned, PLUS add over-correction to a distal rotation.

A "11M" bracket is a mesial rotation bonded bracket applied to teeth with a "mesial" rotation, providing 4 degrees of overcorrection to eliminate the need for finishing bends and to improve the retention experience. Rotating teeth with stainless steel finishing wires is inefficient, time-consuming, requires significant talent, and drains energy from the orthodontist.

A "11D" bracket is a distal rotation bonded bracket applied to teeth with a "distal" rotation, adding 4 degrees of overcorrection to avoid finishing bends and early correction of the rotation for an improved retention experience.

A "11Mli" bracket is a combination bracket having added lingual root torque (torque 22) and mesial rotation. Apply to cases with retroclined upper incisors and/or to cases where significant incisor retraction is planned, AND the tooth has a "mesial" rotation. 4 degrees of over-correction has been added to reduce finishing bends and to improve the retention experience.

A "11Dli" bracket is a combination bracket with added lingual root torque (torque 22) and distal rotation. Apply to cases with retroclined upper incisors and/or to cases where significant incisor retraction is planned, and the tooth has a distal rotation. Four (4) degrees of overcorrection has been added to avoid finishing bends and to allow early correction of the rotation for an improved retention experience.

A "11MLa" bracket has added labial root torque (+2) and mesial rotation of 4 degrees. Use this variation in class III cases to limit upper incisor proclination AND when the incisors have a mesial rotation. It would be unusual, but possible for an upper incisor to be blocked out to the lingual. Retrieving such a tooth would leave the root still in the palate, although the crown was aligned. The added labial root torque would then be desirable to align the root with the adjacent teeth, improving retention. Cases where upper labial corticotomy is planned with rotated incisors, this bracket is perfect.

A "11DLa" bracket has added labial root torque (+2) and distal rotation of 4 degrees. Use this variation in class III cases to limit upper incisor proclination AND when the incisors have a distal rotation. Cases where upper labial corticotomy is planned with rotated incisors, this bracket is perfect.

It should be noted that it is important that all brackets with added labial root torque be tightly tied with steel ligature ties when rectangular archwires are engaged. As the root contacts the labial cortical plate, the crown will pull away from the archwire to the palatal.

Appliances for the upper left quadrant are identical to those for the upper right, except that the numbers start with "2" instead of "1" for the quadrant. The descriptions are the same, except when a specific bracket variation is referenced, the quadrant will change.

Lower Quadrant Brackets

A "36CIIE" bracket is a "bonded" convertible buccal tube with added mesial rotation. Torque –25, angulation 0, rotation 12. At bonding, the bracket position should be altered for added distal crown tip (mesial of the bracket is more gingival), to give some distal crown tip. This variation is designed for cases where significant class II elastics are planned, to reduce the unwanted tooth movements of tipping, and mesial-lingual rotation. If 3mm or more class II needs to be corrected by class II elastics, then this variation will have advantages over a standard Roth prescription.

A "36CIIE2" bracket is a convertible Buccal tube custom welded to a band with added (distal crown) tipback, added mesial rotation, no lingual cleat. Torque –25, angulation 3 (weld), rotation 12. Use this variation in cases where significant class II elastics are planned to reduce the unwanted tooth movements of tipping, and mesial lingual rotation, and mesial crown tipping. The crown tipback adds to the lower arch anchorage, changing the line of force of the elastic, resulting in more tooth translation, and less extrusion.

A "36Up" is a molar uprighting bonded bracket. This convertible buccal tube has added mesial rotation (-12), and added lingual root torque (torque –10) to correct lingual crown inclination. Tipped molars typically have severe mesial-lingual rotation, lingual inclination, and of course mesial crown tipping. The bracket should be bonded to the tooth with added distal crown tip (mesial of the bracket more gingival) to allow full uprighting of the tipped molar.

This bracket may also be applied to a lower 7 or 8 for uprighting. If both the 7 and 8 are to be retained, then the convertible tube in this bracket makes heavy archwire engagement easier while allowing wire bending between the two teeth for the best alignment.

A "36Up2c" is a molar uprighting bracket welded to a band with a lingual cleat. This convertible buccal tube has added mesial rotation (-12), a custom weld for distal crown tipback (5 degrees), and added lingual root torque (torque –10) to correct lingual crown

inclination. Tipped molars usually have severe mesial-lingual rotation, lingual inclination, and of course mesial crown tipping. The lingual cleat may be used to attach posterior cross elastics for further lingual uprighting ability. This band may also be applied to a lower 7 or 8 for uprighting. If both the 7 and 8 are to be retained, then the convertible tube in this bracket makes heavy archwire engagement easier while allowing wire bending between the two teeth for the best alignment.

A "35M" is a mesial rotation bonded bracket with a distal hook and an offset bonding pad. Used on teeth with "mesial rotations", providing 4 degrees of overcorrection to eliminate finishing bends and to improve the retention experience. Full correction of rotations early in treatment, rather than in the finishing stage, will result in more stability in retention. This bracket can also be used to counter the unwanted rotation when applying open coil force to the distal of the bracket, as is common in molar uprighting cases. Using this variation would be critical in pre-implant preparation with open coils, as the control of root positions and rotations is more critical in these cases. The mesial rotation feature will compensate for the unwanted rotation of the bicuspid as force is applied away from the center of rotation.

This variation may also be used in cases with excess spacing and minimum anchorage. Mesial forces applied to the bracket (such as power chain) tend to create a rotation of the bicuspid, which can be compensated by the counter-rotation in the bracket. The offset bonding pad provides needed extra retention, as the lower second bicuspids have the most bonding failures.

With severe mesial rotations of lower second bicuspids, there is risk of creating a posterior crossbite as the alignment wire places a buccal force on the molars when the mesial rotation is activated. The temporary use of a LLA to maintain the molar width during the alignment of severe M rotations on second bicuspids is recommended.

A "35M2" bracket is a mesial rotation bracket welded to a band with a distal hook and no lingual cleat. This variation is used on teeth with "mesial rotations", providing 4 degrees of overcorrection for the purpose of eliminating finishing bends and to improve the retention experience. Full correction of rotations early in treatment, rather than in the finishing stage, will result in more stability in retention.

This bracket can also be used to counter the unwanted rotation when applying open coil force to the distal of the bracket, as is common in molar uprighting cases. Using this variation would be critical in pre-implant preparation with open coils, as the control of root positions and rotations is more critical in these cases. Mesial rotation will help compensate for the unwanted rotation of the bicuspid as force is applied away from the center of rotation.

This variation may also be used in cases with excess spacing and minimum anchorage. Mesial forces applied to the bracket (such as power chain) tend to create a rotation of the bicuspid, which can be compensated by the counter-rotation in the bracket. The offset bonding pad provides needed extra retention, as the lower second bicuspids have the most bonding failures.

A "35D" bracket is a distal rotation bonded bracket with a distal hook and an offset bonding pad. Used on teeth with "distal rotations", providing 4 degrees of overcorrection to reduce finishing bends and to improve the retention experience. Full correction of rotations early in treatment, rather than in the finishing stage, will result in more stability in retention.

This bracket can also be used to counter the unwanted rotation when applying open coil force to the mesial of the bracket, as is common when reopening a lower first bicuspid (4) space. Using this variation would be critical in pre-implant preparation (4s) with open coils, as the control of root positions and rotations is more critical in these cases. The distal rotation compensates for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation.

This variation may also be used when distalizing a bicuspid into edentulous spaces. Open coils are used to distalize the bicuspid, applying forces mesial of the bracket. Forces applied to the mesial of the bracket are also common in maximum anchorage cases to correct protrusion, possibly closing first molar extraction space. The offset bonding pad provides extra retention, and height consistency when bonding first and second bicuspids together. The second bicuspids have more reason to have the offset bonding pad, as the lower second bicuspids have the most bond failures.

A "35D2" bracket is a distal rotation bracket welded to a band with a distal hook and offset pad. Used on teeth with "distal rotations", providing 4 degrees of overcorrection to

reduce finishing bends and to improve the retention experience. Correction and over-correction of rotations early in treatment, rather than in the finishing stage, will result in more stability in retention. This bracket can also be used to counter the unwanted rotation when applying open coil force to the mesial of the bracket, as is common when reopening a lower 4 space. Using this variation would be critical in pre-implant preparation (4s) with open coils, as the control of root positions and rotations is more critical in these cases. The distal rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation. This variation would also be used in bicuspid distalization cases where open coils are used to distalize the bicuspid. Forces applied to he mesial of the bracket are also common in maximum anchorage cases to correct protrusion, possibly closing first molar extraction space.

The hook is applied to the distal for the use of short class II elastics. Since the majority of cases treated are class I or II, the hook placement on the distal has added advantages to the typical practice. Do not change sides with this rotation bracket to get the hook on the mesial, or the rotation will create the wrong rotation. If you must have a hook on the mesial, then use a mesial rotation bracket (welded to a band) on the opposite side, but this is dangerous appliance planning. One mistake with a variation that looks different when bonding, and the problems magnify instead of being corrected.

Bands on bicuspids are used with teeth that have been damaged (large fillings or crowns), severely rotated teeth (mesial rotations), and on cases with skeletal and dental closed bites. The clinical crown of bicuspids in closed bite cases is usually shorter due to the strong muscles of mastication, making bands more suitable for a secure attachment to the tooth.

A "34M" bracket is a mesial rotation bonded bracket with a distal hook and an offset bonding pad. Used on teeth with "mesial rotations", providing 4 degrees of overcorrection to reduce finishing bends and to improve the retention experience.

This bracket can also be used to counter the unwanted rotation when applying open coil force to the distal of the bracket, as is common when opening spaces for lower 5s or molar uprighting. This variation would be critical in pre-implant preparation (5s) with open coils, as the control of root positions and rotations is more critical in these cases. The mesial

rotation compensates for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation.

This variation may also be used in cases with excess spacing and minimum anchorage. Mesial forces applied to the bracket (such as power chain) tend to cause rotation of the bicuspid, which is compensated by the counter-rotation in the bracket. The offset bonding pad provides for extra retention.

A "34M2" bracket is a mesial rotation bracket welded to a band with a distal hook, no lingual cleat.

This bracket can also be used to counter the unwanted rotation when applying open coil force to the distal of the bracket, as is common when opening space for lower 5s or molar uprighting. This variation is critical in pre-implant preparation with open coils, as the control of root positions and rotations is more critical in these cases. The mesial rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation.

This variation may also be used in cases with excess spacing and minimum anchorage. Mesial forces applied to the bracket (such as power chain) tend to create a rotation of the bicuspid, which can be compensated by the extra counter-rotation in the bracket.

The hook is applied to the distal for the use of short class II elastics. Bands on bicuspids are used with teeth that have been damaged (large fillings or crowns), severely rotated teeth (mesial rotation), and on cases with skeletal and dental closed bites. The clinical crown of bicuspids in closed bite cases is usually shorter due to the strong muscles of mastication, making bands more suitable for a secure attachment to the tooth. Since the majority of cases treated are class I or class II cases, the hook placement on the distal has added advantages to the typical practice. In class III cases, this variation can be welded (special request) on the opposite side so the hook is now on the mesial, but a "distal" rotation bracket must be used to create the mesial rotation on the opposite side. Any errors in applying this unusual variation would create the wrong correction.

A "33M" mesial rotation bracket with a distal hook. Torque –11, angulation 7, mesial rotation 4.

This bracket can also be used to counter the unwanted rotation when applying open coil force to the distal of the bracket, as is common when reopening a first bicuspid space. Using this variation would be critical in pre-implant preparation (4) with open coils, as the control of root positions and rotations is more critical in these cases. The mesial rotation will help compensate for the unwanted rotation of the bicuspid as the force is applied away from the center of rotation.

This variation may also be used in cases with excess spacing and minimum anchorage. Mesial forces applied to the bracket (such as power chain) tend to create a rotation of the cuspid, which can be compensated by the extra counter-rotation in the bracket.

When a tooth has a significant mesial rotation, and is to be retracted, choose the mesial rotation rather than the distal rotation needed to offset the distal lingual rotation tendency during retraction.

The following are mesial rotation brackets having the features previously described for MS1 mesial rotation brackets: "31M", "32M", "33M".

The following are distal rotation brackets having the features previously described for MS1 distal rotation brackets: "31D", "32D", "33D".

Appliances for the lower right quadrant are identical to those for the lower left, except that the numbers start with "4" instead of "3" for the quadrant. The descriptions are the same, except when a specific bracket variation is referenced, the quadrant will change.

Combination brackets (i.e. brackets adapted to correct rotations about multiple axis) for 33, 32, 31 (and 43,42,41) also are used with labial root torque + the appropriate rotation for teeth that need additional labial root torque (class III cases) and full/over-correction of a rotation.

Thus, specific embodiments and applications of orthodontic treatment methods and brackets have been disclosed. It should be apparent, however, to those skilled in the art that

many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the appended claims. Moreover, in interpreting both the specification and the claims, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.

IP Software

It is contemplated that preferred software tools will comprise one or more of the following input/output mechanisms: (a) a window based form adapted to facilitate the input, output, and maintenance of patient characteristics (figure 31); (b) a window based treatment option selection form that facilitate the selection and modification of a treatment plans from a set of existing treatment plans (figure 32); (c) an appliance design window adapted to display and allow modifications to a set of appliances to be used (figure 33); (d) a treatment history window adapted to facilitate the input, output, and maintenance of treatment related data (figure 34); (e) a presentation window adapted to facilitate the organization and display of pictures of a patient and the patient's teeth (Figure 35). In preferred embodiments, pictures shown in the window of figure 34 will be enlargeable as shown in figure 36 to permit better viewing of the picture.

The patient characteristic form of figure 31 is used to input the characteristics of a particular patient. Such characteristics may include but are not necessarily limited to: existence and type of crossbite; missing teeth; periodontal condition; dentition; type of bite; arch characteristics; bracket offsets for individual teeth.

The appliance design window of figure 33 allows a dentist to design an appliance that specifically addresses the needs of a particular patient. It will preferably include a graphic illustrating the current form of the appliance being designed. It is contemplated that one or more standard designs may be used as a starting point for the design process. Such standard designs may, either manually via dentist manipulation or automatically via software rules be modified such that a design that is appropriate for a chosen treatment plan and the characteristics of the patient.

Example #1

a. Determining the arch shape and size: The study model is scanned and the inside shape of the mandible is determined (ovoid, tapered, or square) using sample shapes. This is done ONLY on the lower study model. Once one of these 3 shapes is chosen, then the size (small, medium, large, non-extraction) is chosen from the available archform shapes by overlaying the shape over the study model teeth, leaving approx. 2mm of space for the brackets on the face of the teeth.

Next, the treatment planned for that case is factored into the archform. If extraction is the treatment, then the original archform is maintained. If non-extraction is chosen then an enlarged archform is chosen. It is possible to choose one size for the lower and another for the upper in cases with transverse problems (ie. Posterior crossbite).

Next, the esthetic desires of the patient are considered. Those desiring a wide smile may have a larger archform selected (or even a different shape), even in a case that extraction is being done.

Once the lower archform is determined, the upper one is automatically chosen to be "coordinated" unless the doctor edits this for treatment reasons.

b. Determining the width of 2-2 upper/lower for looped wires

Exactly the same as the current mixed dentition analysis program in diagnosticum, the mesial-distal width of the upper and lower incisors is measured. The sum of the incisor width is then used to choose the size of the looped archwires. Since the bracket is set in the middle of the tooth, it seems reasonable to me to select the looped size (size is the distance between loops) to be the measured size plus 1mm on the upper and 2mm on the lower.

c. Ordering standard setup, deleting wires not wanted, adding wires not on the standard setup

There must be standard sets of wires to be used as a starting point in the archwire selection, especially important for new students that have no idea what to select. If a standard set of wires is chosen and later they need another wire, they can get this from the repair kit.

If they do not use one of the wires in the standard single patient setup, they can put the extra wire back into the repair kit.

Standard sets will be listed for:

i. Non-extraction, class I or II case: 014N, 016N, 016ss, 020ss, 19x25ss KH upper, 19x25ss (no loop) lower, 018ss in that order, both upper and lower (total 12 wires)

ii. Non-extraction, class III case: upper: 012N, 014N, 016N, 016ss,020ss,19x25ss (no loop), 21x25ss,018ss. Lower: 016N, 016ss, 020ss keyhole, 018ss

iii. Bicuspid extraction, sliding mechanics: 014N, 016N, 016ss, 020ss, 19x25ss Keyhole, 018ss. All wires upper + lower

iv. Bicuspid extraction, class II with 2 step retraction upper: upper: 014N, 016N, 016ss, combo (or 020ss if not available), 19x25ss T loop, 018ss. Lower: 014N, 016N, 016ss, 020ss, 19x25 keyhole, 018ss

v. Upper 7 molar extraction: upper: 014N, 016N, combo (or 020ss if not available), 19x25ss T loop, 018ss. Lower: 014N, 016N, 020ss, 19x25ss, 018ss

** Each of these wires should be listed for the standard setup with a method to remove that wire and to add from a list of wires for a "custom" setup. The extra wire sizes are listed from the total list of wires available in that shape PLUS the wires not available in that shape, but may be used.

d. reorder repair kit. As wires are used from the wire repair kit, they need to be replaced. This should go with the next NEW patient order, but it is conceivable that we would have to ship out 1 wire someday due to mismanagement of the repair kit inventory by a student. I can see a new dentist not ordering wires for a new patient, but using the wires from the repair kit, reducing inventory to 1 wire of each size!!

Replacement repair kit wires need to be selected from a list, indicating the size and shape (9 possible) and the number needed. This could get complicated. For example: 1 - 19x25KH loop Ovoid-medium, 2 -018ss Square-small, etc are needed in the same order. Hard to list all 500 wires!!

e. Internet order sent/received: Electronic ordering needs to be done as soon as the wires are selected in California PDS (and Spain). The patient name, maybe case number, date the wires needed, doctors name, shipping address (some have 2 practice locations and we do not want to send the wires to the wrong place!), billing info, etc. are needed. Must be easy to use for the doc.

Receipt of the order at PDS is followed by e-mail confirmation with the expected shipping date, arrival to their practice. This is followed by filling the order, generating an invoice (including patient name, doctor name, etc. plus Sales and VAT tax), and shipping (customs tag may be needed) ASAP. Monthly billing by patient name. The sale is recorded and accounts receivable tracked.

f. Shipping label. Electronically generated from the order received with the proper shipping location for that patient.

Thus, specific embodiments of appliances, systems, methods, and tools for orthodontic treatment of patients have been disclosed. It should be apparent, however, to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the appended claims. Moreover, in interpreting both the specification and the claims, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.